

# Detection of Fetal Defects in First Trimester by Ultrasound Examination - Abilities and Limitations

M. Yankova<sup>1,2,\*</sup>, V. Stratieva<sup>2</sup>, P. Chaveeva<sup>2</sup> and G. Hadjidekov<sup>3</sup>

<sup>1</sup>Department of Obstetrics and Gynecology, University Hospital "Lozenetz", Sofia, Bulgaria

<sup>2</sup>O.S.C.A.R. Clinic, Sofia, Bulgaria

<sup>3</sup>Department of Radiology, University Hospital "Lozenetz", Sofia, Bulgaria

**Abstract:** The development of prenatal diagnostics in the recent years and the introduction of the new cell free DNA testing for chromosomal abnormalities raised the question about the effectiveness of the well-known First trimester screening. The need to reassess and to determine the efficacy of the 11-14 week scans in detecting fetuses with chromosomal abnormalities and structural defects arose again. Could the First trimester screening be abandoned and replaced by the new tests? In our practice we find that at 11-14 weeks some abnormalities are always detectable, some can never be and others are potentially detectable depending on their association with increased Nuchal translucency (NT). Fetal structural abnormalities can be classified as major or minor and of early or late onset. After the introduction of a national screening program the prenatal detection rates for all congenital anomalies has increased considerably. Especially anencephaly, gastroschisis and exomphalos are amenable for early detection (in the first trimester). The aim of this study was to determine the efficacy of 11-14 week scan in detecting fetuses with structural anomalies that are almost always detectable in the recent years.

**Keywords:** First trimester, Fetal defects, Holoprosencephaly, Acrania, Hypoplastic left heart syndrome, Omphalocele, Gastroschisis, Megacystis, Body stalk anomaly.

## INTRODUCTION

The possible disappearance of an early trimester ultrasound could seriously affect the percentage of early-diagnosed anomalies, and the advantage of early termination in case of severe anomalies will be lost.

The effective diagnosis of fetal abnormalities is based on the identification of easily recognizable markers, which direct the attention of the sonographer to the specific abnormality. Two very popular examples of such markers are the scalloping of the frontal bones (the 'lemon' sign) and caudal displacement of the cerebellum (the 'banana' sign), observed in the second trimester in most fetuses with open spina bifida, and increased nuchal translucency thickness (NT) [2] which identifies in the first trimester the majority of fetuses with major aneuploidies, lethal skeletal dysplasias and a high proportion of major cardiac defects [8].

It is now clear that the vast majority of most common fetal abnormalities can be diagnosed prenatally by ultrasound, that most of these abnormalities can be detected in the first trimester of pregnancy and that women prefer early first trimester detection rather than later diagnosis.

More than 50% of major structural anomalies can be detected during the first-trimester scan, and the highest rates corresponding to acrania, holoprosencephaly, hypoplastic left heart syndrome, omphalocele, megacystis, fetal hydrops (Figure 9), and body stalk anomaly. The prevalence of holoprosencephaly, exomphalos and megacystis is about 1 in 1300, 1 in 400 and 1 in 1600, respectively. These defects are associated with a high incidence of chromosomal abnormalities (mainly trisomies 18 and 13), found in about 65% of fetuses with holoprosencephaly, 55% with exomphalos and 30% with megacystis. In the majority of cases, exomphalos and megacystis represent temporary abnormalities that resolve spontaneously [1].

## CASE PRESENTATIONS AND DISCUSSION

### 1. Fetal Head and Brain (Figure 1a)

Ultrasonography is the primary screening modality for fetal imaging because of the cost-effectiveness and safety and is widely used for the assessment of fetal brain and head. Both cerebral parenchyma, ventricular system and midline structures can be clearly demonstrated using fetal sonography.

#### 1.1. Holoprosencephaly (Figure 2a)

The diagnosis of alobar holoprosencephaly is based on the fusion of the anterior horns of the lateral

\*Address correspondence to this author at the Department of Obstetrics and Gynecology, University Hospital "Lozenetz" 1, Koziak str.Sofia 1407, Bulgaria; Tel: +359 888 947 836; E-mail: mdyankova@yahoo.com

ventricles and the absence of the butterfly sign in a cross-sectional view of the fetal brain. Alobar holoprosencephaly represent a lethal condition.



**Figure 1(a):** 11 g.w. - There is ossification of the fetal skull, Lateral ventricles – 2/3 choroid plexuses, Symmetrical hemispheres, separated by interhemisphere fissure and falx cerebri.



**Figure 2(a):** Alobar holoprosencephaly.

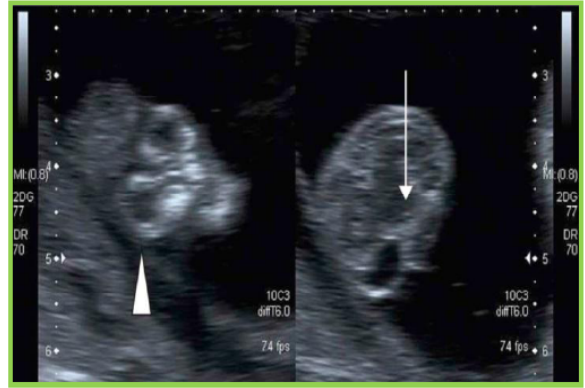
**1.2. Acrania (Figure 2b, 2c)**

Prenatal ultrasonographic diagnostics during second and third trimesters of pregnancy which is based on the demonstration of an absent cranial vault and cerebral hemispheres has been possible for more than 20 years. Since in normal fetuses mineralization of the skull and therefore hyperechogenicity in comparison to



**Figure 2(b):** Acrania - midsagittal view.

the underlying tissues occurs at around 10-th week of gestation, diagnosis of anencephaly by ultrasound is theoretically possible from this gestational age onwards. In the group of the anencephalic fetuses the mean crown-rump length was significantly reduced [9].



**Figure 2(c):** Acrania - "Micky Mouse" face.

**2. FOSSA POSTERIOR (Figure 1b)**

The global volume of the posterior fossa can be determined by fetal ultrasound as well as the position of tentorium cerebella. It enables a morphological and biometrical assessment of posterior fossa structures like cerebellar vermis and cerebellar hemispheres. Dandy-Walker malformations, Blake's pouch cysts, megacysterna magna, vermian hypoplasia are both easily detected in first trimester ultrasound screening.



**Figure 1(b):** Brain stem, 4-th ventricle, cisterna magna, Intracranial Translucency (IT).

**3. SPINA BIFIDA (Figure 3)**

Examination of the posterior brain is feasible in all fetuses in the setting of the routine 11-13 weeks ultrasound examination. Other signs of spina bifida are visible in the mid-sagittal view of the posterior brain, and the assessment of these structures can be a

reliable tool in the early identification of this abnormality [19].

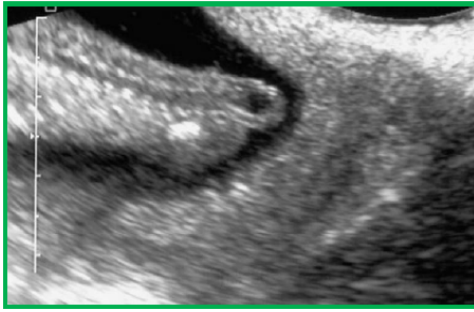


Figure 3: Spina bifida.

**4. ABDOMINAL WALL**

The most common fetal abdominal wall defects are gastroschisis and omphalocele, both with a prevalence of about 3 in 10,000 births. Prenatal ultrasound has a high sensitivity for these abnormalities already at the time of the first-trimester nuchal scan. Major unrelated defects are associated with gastroschisis in about 10% of cases, whereas omphalocele is associated with chromosomal or genetic abnormalities in a much higher proportion of cases. Challenges in management of gastroschisis are related to the prevention of late intrauterine death, and the prediction and treatment of complex forms. With omphalocele, the main difficulty is the exclusion of associated conditions, not all diagnosed prenatally [18].

**4.1. Exomphalos (Figure 4a)**

Exomphalos is diagnosed if there is a herniation of bowel or liver in the base of the umbilical cord and if the CRL  $\geq$  45 mm. The prevalence is 1:380 births, 40% of cases are associated with Trisomy 18.

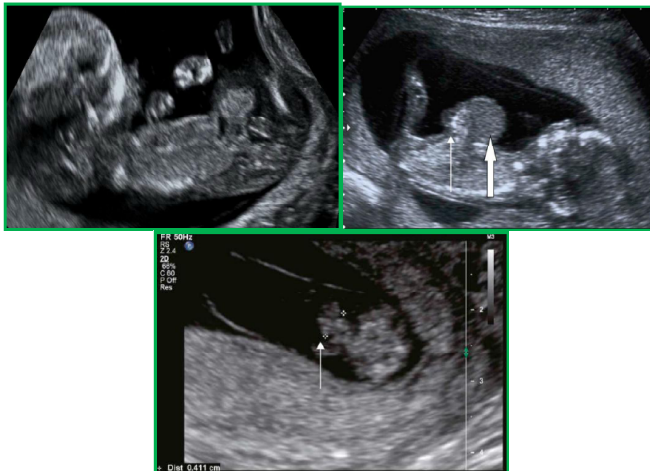


Figure 4(a): Exomphalos.

**4.2. Gastroschisis (Figure 4b)**

The prevalence of this condition is rare - about 1:4000, it represents a sporadic defect with uncertain prognosis.

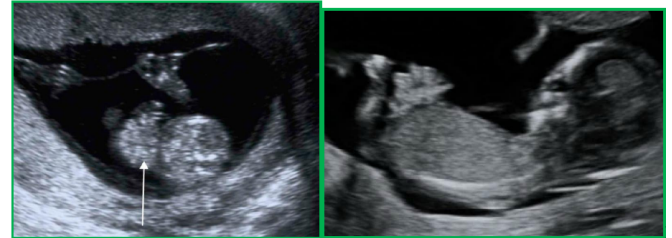


Figure 4(b): Gastroschisis.

**5. FETAL URINARY TRACT**

**5.1. Megacystis (Figure 5)**

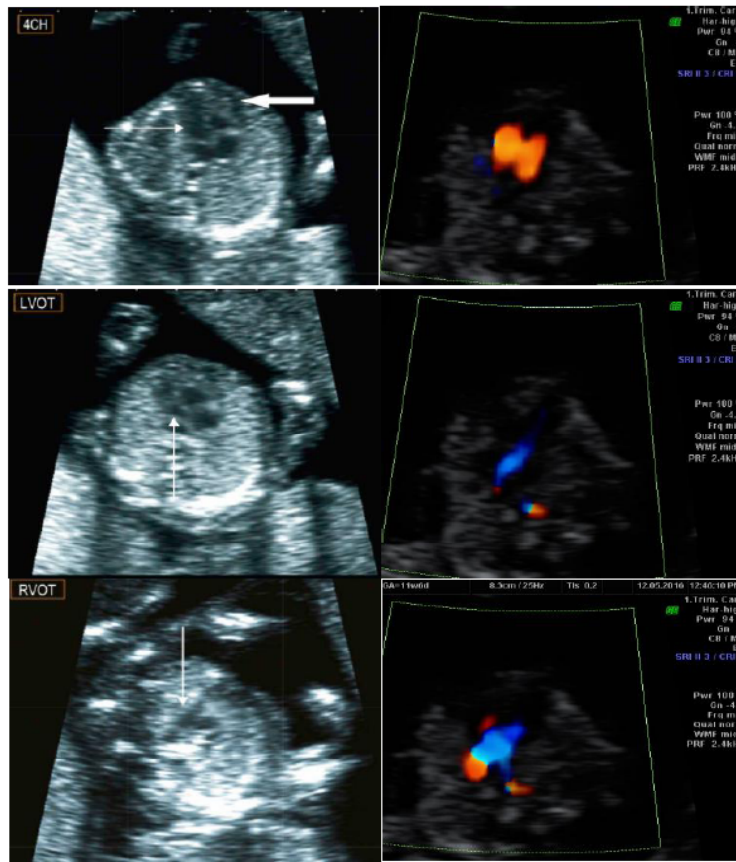
Megacystis is defined as enlarged bladder with a diameter larger than 7 mm. In pregnancies with megacystis of 7-15 mm the parents can be reassured that once the fetal karyotype is found to be normal in about 90% of cases the megacystis will resolve without any obvious adverse effects on renal development and function. The presence of smooth muscle in the bladder and autonomic innervation occur only after 13 weeks; before this gestational age the bladder wall consists of epithelium and connective tissue with no contractile elements. It could therefore be postulated that the majority of cases of fetal megacystis of 7-15 mm may be a consequence of temporary malfunction during a critical stage in the development of bladder function. Nevertheless, in about 10% of cases there may be progression to severe obstructive uropathy [14].



Figure 5: Megacystis.

**6. HEART DEFECTS (Figure 6 a, b, c, d)**

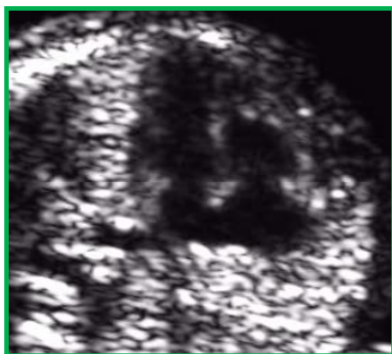
Technical equipment advances are resulting in excellent visualization of the fetal circulatory system even at 12–13 weeks of gestation. Advances over the



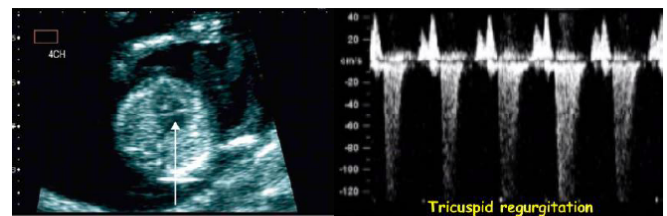
**Figure 6(a):** Doppler examination of the fetal heart: 1. Four chamber view (4CH), 2. Left ventricle outflow (LVOT), 3. Right ventricle outflow (RVOT).

last decade in technology, training and availability of prenatal care have led to a focus on the detection of congenital heart defects (CHD) and its prenatal management for improved pregnancy outcomes [10]. It is now clear that evaluation by two basic cardiac views allows for selection of most cases with a univentricular heart, atrioventricular septal defects, coarctation of the aorta, pulmonary stenosis, pulmonary atresia, and conotruncal defects [11]. Competence in color flow mapping assessment of the fetal heart at gestational ages of 11 weeks to 13 weeks 6 days is achieved only after extensive supervised training [12].

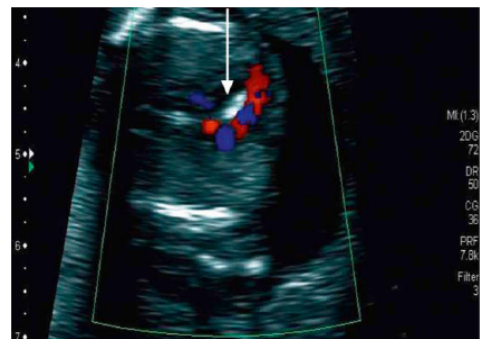
Fetal echocardiography performed at the same visit as NT assessment can identify major heart defects in a very high-risk group with reasonable accuracy, often using transabdominal scanning alone [15].



**Figure 6(b):** 4 chamber view.



**Figure 6(c):** Tricuspid valve.



**Figure 6(d):** Hypoplastic left heart.

## 7. BODY STALK ANOMALY (Figure 7)

Body stalk anomaly is a term used to describe a typical pattern of defects that include encephalocele, facial cleft, an anterior abdominal wall defect, kyphoscoliosis, limb deformities and an absent or short monoarterial umbilical cord.

This is a lethal condition for the fetus and in this case it is advisable to the patient to undergo surgical termination of pregnancy and an uncomplicated procedure can be performed [16].



**Figure 7:** Body stalk anomaly.

## 8. SKELETAL ANOMALIES (Figure 8)

About half of major structural abnormalities can be diagnosed in the first trimester. Increased nuchal translucency or abnormal ductus venosus blood flow appear to be associated with cardiac and skeletal defects and may facilitate early detection [5].



**Figure 8:** Skeletal defects.

## 9. FETAL HYDROPS (Figure 9)

Hydrops fetalis is excessive extravasation of fluid into the third space in a fetus which could be due to heart failure, volume overload, decreased oncotic pressure, or increased vascular permeability. The estimated incidence of this condition is at ~1 in 2000 births although this can significantly vary according to different regions.

### CONCLUSION

The uptake of the combined test in the European countries is notoriously low, not exceeding 30% to



**Figure 9:** Fetal hydrops.

50%. The test is presented mainly as a trisomy screening and women are not aware of the possibility of early diagnosis of severe congenital anomalies. In contrast, over 90% of women choose for 20 weeks scan. Irrespective of the low combined test uptake increasingly more structural anomalies are diagnosed early in pregnancy, but outside a systematic screening offer. The early diagnosis of major fetal defects such as holoprosencephaly, exomphalos, megacystis and major heart defects is an important beneficial side effect of screening for trisomy 21 at 11-13 weeks of gestation.

First three defects are associated with chromosomal abnormalities, especially with trisomies 18 and 13. More than 60% of all antenatally detected malformations by ultrasound were recognized in the 11-14 week scan. Obviously, the second trimester scan also cannot be abandoned, as it provides effective detection of other anomalies [3, 4].

Unfortunately, the sensitivity of these extended protocols for the First trimester assessment is only obtainable in experienced hands, reflecting the additional skill required to obtain these extended views. Close links are required between the tertiary centres and the screening centres to teach and maintain the skills required to obtain and interpret the required views, and to support the sonographer's commitment. Furthermore, an audit system is needed to trace false-positive and - negative cases so that targeted interventions can be planned. Even in a country without a policy of early anatomical fetal assessment, scans performed by certified ultrasonographers lead to a high detection of the majority of severe anomalies < 18 weeks. Of all the anomalies detected at 1st and 2nd trimester US, the majority, over 75%, are detected already in the late first trimester. This allows for early and less traumatic termination of pregnancy (TOP) in the majority of severe and lethal anomalies. This is important, as a missed case of prenatal congenital

defects is potentially a missed opportunity to reduce postnatal morbidity and mortality [13]. Fetal magnetic resonance imaging could be employed as a valuable adjunct and a “problem solver” to prenatal ultrasound especially in controversies and inconclusive findings.

## REFERENCES

- [1] Kagan KO, Staboulidou I, Syngelaki A, Cruz J and KH. Nicolaides. The 11-3-week scan: diagnosis and outcome of holoprosencephaly, exomphalos and megacystis. *Ultrasound Obstet Gynecol* 2010; 36: 10-14 Published online 16 June 2010 in Wiley InterScience
- [2] Syngelaki A1, Chelemen T, Dagklis T, Allan L, Nicolaides KH. Challenges in the diagnosis of fetal non-chromosomal abnormalities at 11-13 weeks. *Prenat Diagn* 2011; 31(1): 90-102. <http://dx.doi.org/10.1002/pd.2642>
- [3] Carvalho MH1, Brizot ML, Lopes LM, Chiba CH, Miyadahira S, Zugaib M Detection of fetal structural abnormalities at the 11-14 week ultrasound scan. *Prenat Diagn* 2002 Jan; 22(1): 1-4. <http://dx.doi.org/10.1002/pd.200>
- [4] Novotná M1, Hašík L, Svábík K, Zizka Z, Belošovičová H, Břešťák M, Calda P. Detection of fetal major structural anomalies at the 11-14 ultrasound scan in an unselected population. *Ceska Gynekol* 2012 Aug; 77(4): 330-5.
- [5] Grande M1, Arigita M, Borobio V, Jimenez JM, Fernandez S, Borrell A. First-trimester detection of structural abnormalities and the role of aneuploidy markers. *Ultrasound Obstet Gynecol*. 2012 Feb; 39(2): 157-63. <http://dx.doi.org/10.1002/uog.10070>
- [6] Blaas HG et al. *Ultrasound Obstet Gynecol* 1994; 4(3): 183-192. <http://dx.doi.org/10.1046/j.1469-0705.1994.04030183.x>
- [7] Lachmann R, Chaoui R, Moratalla J, Picciarelli G, Nicolaides KH, Posterior brain in fetuses with open spina bifida at 11 to 13 weeks, *Prenat Diagn* 2011; 31: 103-6. <http://dx.doi.org/10.1002/pd.2632>
- [8] Chaoui R, Nicolaides KH, From nuchal translucency to intracranial translucency: towards the early detection of spina bifida, *Ultrasound Obstet Gynecol* 2010; 35: 133-8 <http://dx.doi.org/10.1002/uog.7552>
- [9] Johnson SP, Sebire NJ, Snijders RJM, Tunkel S, Nicolaides KH, Ultrasound screening for anencephaly at 10-14 of gestation. *Ultrasound Obstet Gynecol* 1997; 9: 14-6 <http://dx.doi.org/10.1046/j.1469-0705.1997.09010014.x>
- [10] Huhta JC1. First-trimester screening for congenital heart disease, *Curr Opin Cardiol* 2016 Jan; 31(1): 72-7. <http://dx.doi.org/10.1097/HCO.0000000000000248>
- [11] Wiechec M1, Knafel A2, Nocun A2. Prenatal detection of congenital heart defects at the 11- to 13-week scan using a simple color Doppler protocol including the 4-chamber and 3-vessel and trachea views. *J Ultrasound Med* 2015; 34(4): 585-94. <http://dx.doi.org/10.7863/ultra.34.4.585>
- [12] Nemescu D1, Onofriescu M2. Factors affecting the feasibility of routine first-trimester fetal echocardiography. *J Ultrasound Med*. 2015; 34(1): 161-6. <http://dx.doi.org/10.7863/ultra.34.1.161>
- [13] Fenna AR Jansen, Emmeline E Calkoen, Monique RM. Jongbloed, Margot M Bartelings and Monique C Haak. Imaging the first trimester heart: ultrasound correlation with morphology. *Cardiology in the Young* 2014; 24: 3-12. <http://dx.doi.org/10.1017/S1047951114001413>
- [14] Liao AW, Sebire NJ, Geerts L, Cicero S, Nicolaides KH, Megacystis at 10-14 weeks of gestation: chromosomal defects and outcome according to bladder length, *Ultrasound Obstet Gynecol* 2003; 21: 338-41 <http://dx.doi.org/10.1002/uog.81>
- [15] Huggon IC, Ghi T, Cook AC, Zosmer N, Allan LD, Nicolaides KH, Fetal cardiac abnormalities identified prior to 14 weeks' gestation, *Ultrasound Obstet Gynecol* 2002; 20: 22-9 <http://dx.doi.org/10.1046/j.1469-0705.2002.00733.x>
- [16] Paul C, Zosmer N, Jurkovic D, Nicolaides K, A case of body stalk anomaly at 10 weeks of gestation, *Ultrasound Obstet Gynecol* 2001; 17: 157-9 <http://dx.doi.org/10.1046/j.1469-0705.2001.00248.x>
- [17] Sebire NJ, Von Kaisenberg C, Rubio C, Nicolaides KH, Fetal megacystis at 10-14 weeks of gestation, *Ultrasound Obstet Gynecol* 1996; 8: 387-90 <http://dx.doi.org/10.1046/j.1469-0705.1997.08060387.x>
- [18] Prefumo F1, Izzì C2, Fetal abdominal wall defects. *Best Pract Res Clin Obstet Gynaecol* 2014; 28(3): 391-402. <http://dx.doi.org/10.1016/j.bpobgyn.2013.10.003>
- [19] Kappou D1, Papastefanou I, Pilalis A, Kavalakis I, Kassaros D, Souka AP, Towards detecting open spina bifida in the first trimester: the examination of the posterior brain. *Fetal Diagn Ther* 2015; 37(4): 294-300. <http://dx.doi.org/10.1159/000365920>

Received on 21-06-2016

Accepted on 15-07-2016

Published on 29-07-2016

<http://dx.doi.org/10.15379/2408-9761.2016.03.02.03>

© 2016 Yankova et al.; Licensee Cosmos Scholars Publishing House.

This is an open access article licensed under the terms of the Creative Commons Attribution Non-Commercial License

(<http://creativecommons.org/licenses/by-nc/3.0/>), which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited.